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Germ Plasm Evaluation Program

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Tuli. The Tuli, a Sanga type of cattle (non humped), was developed relatively recently in a research program initiated in the 1940's using foundation cattle considered to be the most productive type selected from indigenous Tswana cattle in Zimbabwe. Australian scientists at CSIRO, Tropical Agricultural Research Station, Rockhampton, Queensland, and a consortium of private breeders in Australia imported frozen Tuli embryos from Zimbabwe into Australia in 1990. Semen from nine Tuli bulls was imported from Australia for use in the experiment.

Boran. Borans are a pure Zebu breed (*Bos indicus*, humped) that evolved in southern Ethiopia and are believed to have been developed for milk and meat production under stressful tropical conditions. They were imported into Australia from East Africa (Zambia). Semen from eight Boran bulls was imported from Australia for the experiment.

Brahman. Semen from a current breed sample of at least 30 Brahman (Grey and Red) bulls was used to produce F1 progeny. Semen was used from sires sampled in Cycle III of the GPE Program (bulls produced in the early 1970's) to facilitate pooling of data over cycles and estimate genetic trends.

Belgian Blue. Muscle hyperplasia (double muscling) has been favored for at least 40 years by Belgian Blue breeders in Belgium. Semen from 26 bulls is being used in the experiment.

Piedmontese. Piedmontese originate in the Piedmont region of northern Italy. Seventeen Piedmontese sires included in Cycle IV of the program were repeated to produce one calf crop (1992) in Cycle V.

Calves were produced in the spring of 1992. A sample of 79 male calves were left intact to evaluate growth and pubertal development of bulls. The remaining male calves were castrated within 24 hours of birth. Calves were creep fed whole oats from mid July until weaning in early October.

Steers. Following a postweaning adjustment period of about 30 days, steers were penned and fed separately by sire breed for an average of 230 days. The growing diet contained about 2.7 Mcal ME/kg and 12.9% crude protein and the finishing diet fed from about 700 lb to slaughter contained about 3.04 Mcal ME/kg and 10.9% crude protein. Representative samples of steers were slaughtered serially in 3 slaughter groups spaced 28 days apart. The steers were slaughtered in a commercial facility and hot carcass weights were obtained and used to estimate dressing percent (100 X carcass weight/final live weight). After a 24-hour chill, USDA yield grade (fat thickness, longissimus area, estimated % kidney fat, carcass weight) and quality grade (marbling, maturity) data were obtained. The right side of the carcass was transferred to the meat laboratory at MARC and fabricated into closely trimmed (8 mm fat thickness) and totally trimmed (0 mm fat thickness) and boneless, retail product (steaks, roasts and lean trim with 20% chemical fat content), fat trim and bone. Retail product, fat trim and bone from the right side was doubled to estimate retail product yield from the carcass. Warner-Bratzler shear determinations and sensory panel determinations of tenderness, juiciness and beef flavor intensity were determined on cooked rib steaks after 7 days postmortem aging.

Heifers. After weaning and a 42 day adjustment period, heifers were assigned to two pens per sire breed (Hereford and Angus sired females were treated as a single sire breed). In each sire breed, one pen of about 30 heifers was fed a "moderate" energy level consistent with that used in previous cycles of the GPE Program, and the second pen of about 30 heifers received 80% (as fed) of the feed given to the moderate group. The extra heifers (excess over 60 head per sire breed) were mixed together in two pens and fed the moderate energy level. Heifers were fed a 60% corn silage-35%-alfalfa haylage-5% protein mix (as fed) diet for 168 days. Females were checked visually twice daily for estrus beginning on February 1. Surgically altered teaser bulls, rotated weekly, were used to facilitate estrus observation. Weights were taken at 28 day intervals from weaning to the beginning of the breeding period. Heifers were moved to grass pasture on May 5, at which time both treatments were combined and run together. Heifers were exposed to Red Poll bulls, for a 63 day breeding season beginning on May 19. Body weights were taken at the beginning and end of the

breeding season. Heifers were weighed and pregnancy tested about 45 days after bulls were removed.

Bulls. Following weaning, 79 bull calves were placed in two pens in a drylot, and fed a diet of corn silage, rolled corn and protein-mineral-vitamin supplement (2.69 Mcal ME/kg dry matter, 12.88% crude protein) for 9 months. At 28 day intervals, body weight, hip height, and scrotal circumference were measured. Electroejaculated semen collections were begun when bulls reached a scrotal circumference of 26 cm and continued at 28 day intervals until bulls reached puberty (first produced an ejaculate containing at least 500 x 10^6 sperm with ≥50% progressive motility).

Preweaning data were analyzed by mixed model procedures using a model that included fixed effects for sire breed, dam breed, age of dam (5, 6-8, 9, ≥ 10 yr), sex of calf, sire breed-dam breed, and sire breed-sex, and random effects of sire and progeny within sire. Postweaning growth and carcass data on steers were analyzed by least squares procedures using a model that included fixed effects for sire breed, dam breed, age of dam (5, 6-8, 9, ≥ 10 yr), sire breed-dam breed, and covariates for age at weaning (mean = 180 d) and days fed postweaning (mean = 261 d). Data on growth and puberty traits of heifers were analyzed by least squares procedures using a model that included fixed effects for sire breed, dam breed, cow age, feeding level, and two factor interactions for sire breed-dam breed and sire breed-feeding level. The average least significant difference (LSD .05) among sire breed contrasts is presented for each trait. Differences as large or larger than LSD .05 are expected to result from chance only 5 times out of 100 in experiments of the same magnitude.

PRELIMINARY RESULTS

Breed group means averaged over Angus, Hereford and MARC III dams are shown in Table 2 for preweaning traits. Breed group means for final weight of steers and certain carcass and meat characteristics, adjusted to 441 days of age, are shown in Tables 3, 4, and 5. Breed group means for growth and puberty traits of heifers are shown in Table 6. Breed group means for pubertal development traits of F1 males are shown in Table 7. These results are preliminary. Data for preweaning traits were taken on calves produced in two of three calf crops to be produced in Cycle V of the program. Data on postweaning growth and carcass traits of steers and on growth and puberty traits of heifers and bulls were obtained on the first of three calf crops to be produced in Cycle V.

Progeny of Boran, Brahman and Tuli sires had longer gestation length than those of Hereford, Angus and Belgian Blue sires. Gestation length was intermediate in length for progeny of Piedmontese sires compared to other breeds. Birth weights were significantly heavier for progeny of current Brahman sires (born since 1988) than for progeny of Brahman sires originally sampled and used in Cycle III of the GPE Program (born prior to 1973). Progeny of Boran sires were lighter in birth weight than progeny of Brahman sires but heavier than progeny of the *Bos taurus* breeds evaluated (i.e., Hereford, Angus, Piedmontese and Belgian Blue). Progeny of Hereford, Angus, Piedmontese and Belgian Blue sires were similar in birth weight. Progeny of Tuli sires had lighter birth weight than progeny by any other sire breed. In general, calving ease (unassisted calvings, %) was associated with birth weight of the progeny, except that progeny of Belgian Blue sires required relatively more assistance at calving than calves with comparable birth weights by other sire breeds, and progeny of original Brahman sires required relatively little assistance considering the relatively heavy birth weight of their progeny.

Steer progeny of Hereford, Angus and Belgian Blue sires were heavier at slaughter (441 days) than those of Brahman, Piedmontese, Boran, or Tuli sires ($P<.05$). Results for carcass and meat traits for progeny of Brahman sires will not be presented separately for sires born prior to 1973 and sires born in 1988 or later until more data are available from additional calf crops. Mean marbling score was greater in progeny of Angus, Tuli, Hereford and

Boran sires than in progeny of Piedmontese, Brahman, and Belgian Blue sires (P<.05). Progeny of Angus, Tuli and Hereford sires graded USDA Choice with a higher frequency than those of Piedmontese, Brahman or Belgian Blue sires (P<.05). Shear force and sensory panel estimates of tenderness of longissimus muscle steaks were significantly more favorable for progeny of Belgian Blue, Piedmontese, Angus, Hereford, and Tuli sires than for progeny of Boran or Brahman sires. Sensory panel estimates for juiciness were lower for progeny of Brahman sires than for progeny of other sire breeds.

Mean weight of retail product was greater for progeny of Belgian Blue sires than Piedmontese sires (P<.05) which was greater than that of Hereford, Angus or Brahman sires, which was greater than that of Tuli and Boran sires (P<.05). Although live weights of Piedmontese were significantly lighter than those of Angus or Hereford sires, weight of retail product was greater because of their higher dressing percentage and greater percentage of retail product. Mean percentage fat trim was less in progeny of Belgian Blue and Piedmontese sires than in progeny of Brahman sires which was less than that in progeny of Angus, Hereford, Boran or Tuli sires (P<.05). Percentage bone for Tuli and Boran was less than that in progeny of Belgian Blue sires (P<.05), and more intermediate forPiedmontese, Angus, Hereford and Brahman.

Mean 365 day weights in heifers were heavier for progeny of Hereford sires than progeny of all other sire breeds (P<.05), except for Angus. Heifer progeny of Belgian Blue sires were heavier than those of Piedmontese sires or progeny of Brahman, Boran or Tuli sires (P<.05). Brahman F1 crosses were significantly heavier than Tuli F1 crosses, neither of which differed significantly from Boran F1 crosses which had a more intermediate mean 365 day weight. A high percentage of the females expressed estrus, prior to June 14 when estrus observations were discontinued, in all breed groups except Brahman. Mean age at puberty was relauvely young for heifer progeny of Piedmontese, Belgian Blue, Hereford and Angus sires, rankings significantly older for progeny of Brahman sires than any other breeds, and intermediate for progeny of Boran and Tuli sires. Breed group means for pregnancy rate of heifers tended to correspond tofor age at puberty.

Preliminary results for scrotal circumference and age at puberty (i.e., age when bulls produced 500 million sperm per ejaculate) are summarized in Table 7. Scrotal circumference at 7 months of age was smallest in Brahman, intermediate in Boran and Belgian Blue, and largest in Tuli and Hereford-Angus sired crosses Hereford-Angus and Belgian Blue bulls reached puberty earliest, Tuli tended to be intermediate, and Boran and Brahman sired bulls were the oldest at puberty All bulls reached puberty at 30 to 32 cm scrotal circumference. Brahman and Boran sired bulls were heavier at puberty than Hereford-Angus, Tuli, or Belgian Blue sired bulls.

DISCUSSION

Preliminary results indicate that Belgian Blue and Piedmontese are excellent candidates as terminal sire breeds. Additional data are needed to characterize reproduction and calving traits of backcross and F2 (e.g., Piedmontese-Angus X Piedmontese-Angus) progeny to assess their potential for use in rotational crossing systems or composite populations.

Preliminary results indicate that Tuli cattle, which have evolved in the tropics, produce crossbred progeny with carcass and meat characteristics more similar to progeny sired by British *Bos taurus* breeds (i.e., Hereford and Angus) than to progeny sired by *Bos indicus* breeds (i.e., Brahman or Boran). Cooperative research efforts are in progress to evaluate reproduction and maternal performance of F1 cows by Tuli, Boran and Brahman sires at research stations located in subtropical regions of the U.S. (i.e., Florida, Georgia, Texas, New Mexico and Oklahoma).

TABLE 1. SIRE BREEDS USED IN GERMPLASM EVALUATION PROGRAM AT MARC

Cycle I (1970-72)	Cycle II (1973-74)	Cycle III (1975-76)	Cycle IV (1986-90)	Cycle V (1992-94)
F1 crosses from Hereford or Angus dams (Phase 2)[a]				
Hereford	Hereford	Hereford	Hereford	Hereford
Angus	Angus	Angus	Angus	Angus
Jersey	Red Poll	Brahman	Longhorn	Tuli
S. Devon	Brown Swiss	Sahiwal	Salers	Boran
Limousin	Gelbvieh	Pinzgauer	Galloway	Belgian Blue
Simmental	Maine Anjou	Tarentaise	Nellore	Brahman
Charolais	Chianina		Shorthorn	Piedmontese
			Piedmontese	
			Charolais	
			Gelbvieh	
			Pinzgauer	
3-way crosses out of F1 dams (Phase 3)				
Hereford	Hereford			
Angus	Angus			
Brahman	Brangus			
Devon	Santa Gertrudis			
Holstein				

[a]In Cycle V, composite MARC III (1/4 Angus, 1/4 Hereford, 1/4 Pinzgauer and 1/4 Red Poll) cows are also included.

TABLE 2. BREED GROUP MEANS FOR PREWEANING TRAITS OF CALVES PRODUCED IN CYCLE V OF THE GPE PROGRAM

(Preliminary Results, Calves Born 1992-1993)

Sire breed of calf	No. calves		Gestation length	Calvings unassisted	Birth weight	Calf surv.	200-d weight	
	Born	Weaned	days	%	lb	%	Units lb	Ratio %
Hereford	197	186	286.8	97.4	96.2	93.5	530	100.1
Angus	176	170	284.3	97.0	92.0	99.6	529	99.9
Avg.	363	356	285.5	97.2	94.1	96.6	529	100.0
Brahman (orig.)	103	94	293.0	95.7	100.4	88.6	538	101.6
Brahman (cur.)	176	162	293.4	90.7	105.1	89.5	538	101.6
Boran	285	269	293.4	95.5	97.9	93.2	508	96.1
Tuli	312	300	291.7	98.2	86.8	96.1	499	94.2
Piedmontese	144	140	290.2	95.2	94.1	97.4	507	95.8
Belgian Blue	310	293	285.6	92.9	94.6	94.3	528	99.7
LSD .05			2.4	4.7	4.3	5.0	19	3.6

TABLE 3. BREED CROSS MEANS IN FINAL WEIGHT AND CARCASS TRAITS OF STEERS (ADJUSTED TO AVERAGE AGE AT SLAUGHTER OF 440 DAYS)

Cycle V - Phase 2 (Preliminary Results, 1992 Calf Crop)

Breed group of steer	No.	Final wt. lb	Dress. pct. %	Fat thick-ness in	Rib eye area sq in	Marb-ling score sc	USDA Choice %
Hereford	9	1280	60.1	.41	11.29	525	70.8
Angus	10	1232	60.1	.48	11.32	568	90.6
Average	19	1256	60.1	.45	11.31	546	80.7
Brahman	27	1164	60.5	.34	10.96	465	23.3
Boran	30	1115	60.0	.43	11.27	519	54.7
Tuli	47	1106	60.8	.44	10.84	548	80.4
Piedmontese	35	1156	61.4	.20	12.72	477	35.5
Belgian Blue	28	1231	61.8	.21	12.91	460	21.3
LSD .05		63	1.4	.10	.68	42	31.7

TABLE 4. BREED CROSS MEANS IN MEAT TENDERNESS AND PALATABILITY CHARACTERISTICS OF RIB STEAKS FROM STEERS (ADJUSTED TO AVERAGE AGE AT SLAUGHTER OF 440 DAYS)

Cycle V - Phase 2 (Preliminary Results, 1992 Calf Crop)

Breed group of steer	No.	WB Shear 7 days aging	WB Shear 14 days aging	Sensory panel (7 days aging) Tender-ness sc	Flavor sc	Juici-ness sc
Hereford	9	13.1	11.2	5.01	4.74	5.07
Angus	10	12.6	9.0	5.04	4.56	5.24
Average	19	12.9	10.1	5.03	4.65	5.16
Brahman	27	17.8	15.2	4.08	4.44	4.79
Boran	30	16.1	12.1	4.58	4.38	5.15
Tuli	47	13.1	11.0	5.02	4.56	5.27
Piedmontese	35	12.8	10.6	5.03	4.57	5.05
Belgian Blue	28	12.8	10.4	5.07	4.64	5.07
LSD.05		2.5	2.5	.56	.25	.33

TABLE 5. BREED CROSS MEANS IN RETAIL PRODUCT YIELDS OF STEERS
Cycle V - Phase 2 (Preliminary Results, 1992 Calf Crop)

		3 in trim		0 inch trim					
		Retail prod.		Retail prod.		Fat trim		Bone	
Breed group	No.	%	lb	%	lb	%	lb	%	lb
Hereford	9	67.4	494	61.5	450	23.8	176	14.6	107
Angus	10	69.3	486	63.4	445	22.2	156	14.4	101
Avg. HA-cross	19	68.4	490	62.5	447	23.0	166	14.5	104
Brahman	27	70.4	475	64.6	436	20.6	141	14.8	100
Boran	30	68.3	430	62.3	391	24.1	156	13.7	86
Tuli	47	67.8	431	61.9	392	24.2	155	13.9	89
Piedmontese	35	75.7	505	71.1	474	14.5	99	14.4	96
Belgian Blue	28	74.1	538	69.2	502	15.6	115	15.1	110
LSD .05		2.8	27	2.4	26	2.7	23	.6	7

TABLE 6. BREED GROUP MEANS FOR GROWTH AND PUBERTY TRAITS OF HEIFERS
Cycle V - Phase 2 (Preliminary Results, Heifers Born in 1992)

Breed group of female	No.	365-day weight lb.	Puberty expressed %	Age at puberty Act. d	Age at puberty Adj. d	Preg. rate %
Hereford	31	835	94.4	348	352	83.7
Angus	20	808	95.8	356	359	97.3
Avg.	51	821	95.1	352	355	90.5
Brahman (old)	14	698	55.5	412	437	50.3
Brahman (curr)	52	740	77.1	393	407	83.6
Avg.	66	731	72.5	396	412	76.5
Boran	59	701	97.3	378	380	95.4
Tuli	69	681	91.9	380	386	83.1
Piedmontese	72	719	98.7	339	340	95.1
Belgian Blue	61	784	98.8	341	343	92.0
LSD .05		31	11.1	18	20	13.6

TABLE 7. BREED GROUP MEANS FOR GROWTH AND PUBERTAL DEVELOPMENT OF F1 MALES

Cycle V - Phase 2 (Preliminary Results, Bulls Born in 1992)

Breed group	No.	Scrotal circumference			At puberty (500 m sperm)		
		7 mo	12 mo	17 mo	Age	Weight	Scrot circ.
		cm	cm	cm	d	kg	cm
Hereford and Angus Avg.	18	26.9	33.8	37.5	315.4	424	31.9
Brahman	18	21.8	29.7	35.2	403.9	464	32.1
Boran	14	23.7	30.4	35.4	406.7	464	32.1
Tuli	14	25.4	29.2	34.1	389.3	407	30.4
Belgian Blue	15	24.3	31.7	34.9	324.1	403	30.2
LSD .05		1.6	1.5	1.5	34	43	.9